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PROCEEDINGS OF

DEPARTMENT OF DEFENSE
COST RESEARCH
SYMPOSIUM

MARCH 2-3
1966

COMPILED BY
OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE
(SYSTEMS ANALYSIS)

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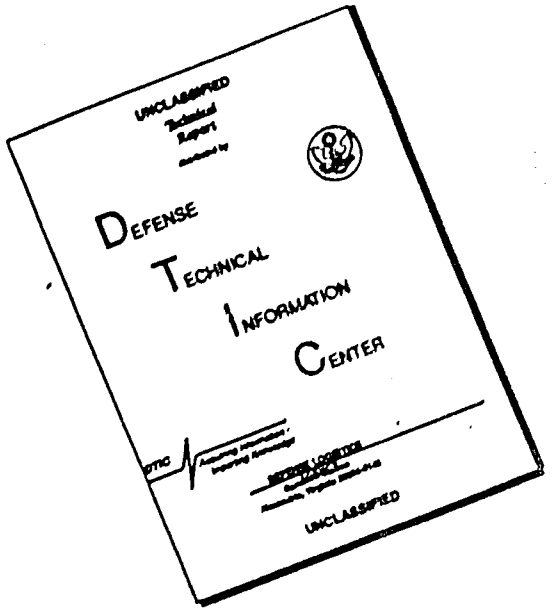

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PROCEEDINGS OF DEPARTMENT OF DEFENSE

COST RESEARCH SYMPOSIUM

March 2-3, 1966

400 Army-Navy Drive
Arlington, Virginia

May 5, 1966

Compiled by:
Office of Assistant Secretary of Defense (Systems Analysis)

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FOREWORD

This document contains abstracts of each of the papers presented during the two day DOD Cost Research Symposium held March 2-3, 1966, in Arlington, Virginia. In addition, the message for the Symposium from the Secretary of Defense (read at the Symposium, during his opening remarks, by Alain C. Enthoven, Assistant Secretary of Defense for Systems Analysis); and the concluding remarks made by Harold Asher, Deputy Assistant Secretary of Defense (SA) Resource Analysis, are included in their entirety.

The purpose of the Symposium was to provide a forum for the interchange of ideas and techniques and to generate a greater awareness among personnel engaged in cost analysis of the potentialities of their profession and its importance for the effective operation of the Department of Defense.

SYMPOSIUM PROGRAM

WEDNESDAY, MARCH 2, 1966

8:45 - 9:15 = Opening Remarks, Honorable Alain C. Enthoven, Assistant Secretary of Defense

9:15 - 12:15 = Army Presentations, Chairman: Mr. Richard J. Trainor, Director of Cost Analysis, Office, Comptroller of the Army

- "DA Organization for Cost Research," Mr. T. Arthur Smith, Chief, Cost Research Division, OCA
- "RAC Cost Research Program," Mr. Arnold Proschan, Deputy Head, Economics and Costing Department, RAC
- "RAC Manpower Strength and Cost Model," Mr. Gilbert Bernstein, Economics and Costing Department, RAC
- "Progress Report - The Individual System/Organization Cost Model," Mr. Don Strope, Economics and Costing Department, RAC
- "Main Battle Tank," Mr. Frank Dahlhaus, Headquarters, Army Materiel Command
- "Cost Estimating by the Comparator System of Evaluation," Mr. Victor V. Robertson, Army Missile Command
- "Generalized Cost Estimating Equations for Helicopters," Mr. Norman Smith, Army Aviation Command

12:15 - 2:00 = LUNCH, Speaker - Mr. David Novick, Head, Cost Analysis Department, RAND

Wednesday, March 2, 1966 Cont'd

2:00 - 5:30 = Air Force Presentations, Chairman: Colonel John D. Morgan, Chief, Cost Division, Directorate of Air Force Budget, Headquarters, USAF

- "The USAF Cost Analysis Program: Organization, Concepts, Accomplishments, and Plans," Major General Duward L. Crow, Director of Budget, Headquarters, USAF

- "USAF Cost Models Operation and Research," Mr. Kenneth Conley, Chief, Cost Analysis Branch, Cost Division, Headquarters, USAF

- "USAF Cost Estimating Relationship/Cost Factors Program," Mr. Riner C. Payne, Chief, Cost Factors Branch, Cost Division, Headquarters, USAF

- "Role of AFSC in Cost Analysis," Colonel Jack Henderson, Director of Cost Analysis, Headquarters, AFSC

- "Research on Framework for Total Force Structure Cost Analysis," Mr. Brent D. Bradley, Cost Analysis Department, RAND

- "Some Methodological Problems of Airframe Cost Estimation," Mr. Stephen M. Barro, Cost Analysis Department, RAND

- Open Discussion and Summarization

THURSDAY, MARCH 3, 1966

*:45 - 11:45 = Navy Presentations, Chairman: Mr. Dick L. Jackson
Director, Progress Reports and Statistics Division,
Navy Comptroller

- "Costing in the Department of the Navy," RADM E. E. Grimm, Director, Budget and Reports, Navy Comptroller

- "Navy Cost Information System," Mr. Dick L. Jackson, Director, Progress Reports and Statistics Division, Navy Comptroller

- "Navy Cost Model," Mr. Culbert Laney, General Planning and Programming Office, CNO

- "CNA Cost Analysis Organization and Highlights of Research," Mr. Donald Weir, Head, Cost Analysis Division, CNA

- "Highlights of Navy Cost Research Projects Other Than Those of the Center of Naval Analyses," Captain L. P. Daniels, Head, Contract Information Branch, CNM

- "Escort Ship System Cost Analysis," Mr. R. P. Caldarone, Cost Analysis Division, CNA

- "P-3A Utilization and Support Requirements Study," Mr. Donald H. Sunde, Technical Director, Weapon Systems Analysis Office, BuWeps, Quantico, Virginia

11:45 - 12:30 = OSD Presentations, Chairman: Mr. Saul Hoch, Director, Cost Research and Analysis, OASD (SA) -- Part I.

- "Introduction and Overview," Mr. Saul Hoch, Director, Cost Research and Analysis, OASD (SA)

- "Statistical Cost Estimating Relations - Some Basic Issues (Aircraft Examples)," Mr. Harry P. Hatry, Cost Research and Analysis, OASD (SA)

Thursday, March 3, 1966 Cont'd

12:30 - 1:45 = LUNCH

1:45 - 4:00 = OSD Presentations -- Part II.

- "CER's: Missiles and Related Subsystems," Keith E. Marvin, Cost Research and Analysis, OASD (SA)

- "Statistics in Cost Predictions and Potential," Harry Piccariello, Cost Research and Analysis, OASD (SA)

- "Costing Guidelines and Handbooks," LCDR M. Staser Holcomb, Cost Research and Analysis, OASD (SA)

- "Data Systems Developments," Colonel Herbert Waldman, Directorate for Assets Management Systems, OASD (C) - Management Systems Development

4:00 - 4:30 = "Department of Defense Cost Analysis Courses," Colonel Troy Jones, Air Force Institute of Technology

4:30 - 5:15 = "Symposium Summary and Plans for the Future," Harold Asher, Deputy Assistant Secretary of Defense (SA) Resource Analysis

Letter from Robert S. McNamara

and

Abstract of Opening Remarks - Alain C. Enthoven

THE SECRETARY OF DEFENSE
WASHINGTON

FEB 24 1966

MEMORANDUM FOR ASSISTANT SECRETARY OF DEFENSE (SYSTEMS ANALYSIS)

SUBJECT: First Department of Defense Cost Symposium

I wish to express my pleasure and satisfaction that the first Department of Defense Cost Symposium is being held. Good cost analysis is fundamental to our planning for new weapon systems in the Department of Defense. Today, it is more important than ever that we improve our capability for estimating accurately the expected costs of military programs. Effective use of our resources requires that we have good estimates of the probable cost of the alternatives available to us. A poor cost estimate can lead to a wrong selection and, in turn, to a waste of resources, disruptive reprogramming actions, reduced effectiveness, and many other undesirable effects. Unfortunately, our history includes far too many poor cost estimates.

I have urged the Secretaries of the Military Departments to support and provide resources for improved cost estimation capabilities. I hope that this Cost Symposium will contribute significantly by providing a forum for the interchange of ideas and techniques, and by generating a greater awareness among personnel engaged in cost analysis of the potentialities of their profession and its importance for the effective operation of the Department of Defense.

Please extend my best wishes to all of the participants in the Symposium.

Robert S. McNamara

OPENING REMARKS

Alain C. Enthoven
Assistant Secretary of Defense - Systems Analysis

Dr. Enthoven in his remarks stressed the importance of good cost estimating to force planning. He provided a number of examples where cost estimates have played an important role in the decision-making process. He also emphasized the need for the Military Departments to have their own capability to estimate independently the costs of its weapons systems on a thoroughly professional basis. He pointed to some examples in the past of estimates that turned out to be very poor and suggested the probable consequences. He encouraged the people throughout DOD concerned with cost analysis to make a serious effort to maintain and improve their technical skills so as to keep their knowledge up-to-date. He urged upon the Departments an aggressive, imaginative, recruiting program to obtain high quality, professionally trained, individuals to meet the rapidly expanding requirement for cost analysis personnel.

ABSTRACTS OF

ARMY PRESENTATIONS

DEPARTMENT OF THE ARMY ORGANIZATION FOR COST RESEARCH

Mr. T. Arthur Smith
Chief, Cost Research Division
Office, Comptroller of the Army

The Army Headquarters organization responsible for development and implementation of Army-wide cost analysis systems and direction is the Directorate of Cost Analysis, Office of the Comptroller of the Army. This is a relatively new organization that has been functioning as a completely separate entity only since October 1965. The Directorate has three divisions. The Cost Estimates Division is primarily concerned with the preparation of estimates to support the Army position in planning and programming documents. The Cost Information Division prepares the Army Cost Factors Handbook, surveys Army cost data holdings, and coordinates cost information requirements within the Department of the Army.

The Cost Research Division has responsibilities for: improving costing methodology in the Department of the Army, supporting and directing cost analysis research, conducting research in the area of cost data storage and retrieval, developing methodology for Army-wide systems for analyzing resource requirements, developing training and orientation programs for Army cost analysts. These responsibilities are carried through the utilization of the skills of DA civilian operations research analysts, the Research Analysis Corporation, and contractor personnel.

Most of the cost analysis research performed outside DA Headquarters is done within the Army Materiel Command. Analysis groups have been established within the Office of the Director for Procurement and Production at AMC Headquarters and at the major sub-commands. These groups prepare cost estimates, support the DOD Cost Information Reporting System, the OSD Economic Impact Program, and develop specialized methodologies and cost estimating relationships.

RAC COST RESEARCH PROGRAM

Mr. Arnold Proschan
Deputy Head, Economics and Costing Department
Research Analysis Corporation

The following are the major projects in RAC's current costing program.

Individual System/Organization Cost Models (ISOC). In a study pertaining to surveillance aircraft, we were faced with the problem of making many computations of cost to reflect variation in input values -- a sensitivity analysis. A set of computer programs was developed for this purpose. We then found that we were able to use these programs for other cost studies, involving multi-equipment organizations, tactical air defense, and missile systems.

The cost models so developed are not very sophisticated. Only one of them incorporates any time-phasing. The models are far less ambitious than force cost models. Nevertheless, they are quite useful for sensitivity analysis.

Active Forces Strength and Cost Model. Last year we were involved in a DOD Military Manpower Policy Study. Our assignment was to develop strength projection and cost models to permit the testing of alternative policies on the draft and on military manpower procurement. We developed models for the active forces and for the civilian manpower pool. Many runs were made for the Office of the Assistant Secretary of Defense (Manpower), and after the study was concluded, additional runs were made for the Army on alternatives of special interest to it.

Incremental System and Organization O&M Costing. We have developed a procedure for costing an additional system or organization. It is the incremental costs stemming from the added units which is of concern here. To develop meaningful cost estimating relations we have had to get away from the standard budget classifications and consider the underlying activities. We have had to focus on the cost-generating factors -- the additional manpower and materiel and the activity levels. After we have applied the CERs developed for the various activities, we can translate the cost answers into the standard budget classifications. We plan to continue effort in this field of research.

Combat Division Training and Resource Requirements. For the Brown Board, a group engaged in a broad study of logistics, we are developing a costing methodology to translate a specific combat division training program into its resource implications. This we do through translating

a division training program into the required utilization of combat vehicles and other equipment, and then determining the costs stemming from the use of equipment. We have some sample relationships for costing the use of equipment, based on the work of the Logistics Department. We are at present involved in determining whether it is feasible to use data generated in the Army's TAER system as a basis for cost estimating relations. Our hope is that a system can be developed that the Army can operate with its own data inputs.

Individual Training Costs. We are doing work to determine an appropriate method for costing training. We have examined costs at three Service schools and three basic training centers. We find that the schools themselves are concerned primarily with the elements of cost for which the schools have funding responsibility. We take a more comprehensive view of relevant cost elements. We need to do more work to emphasize incremental costing as against average cost per man.

Costing Guides. We are developing cost methodology guides which can be used by our own cost analysts and by Army analysts. These guides will supplement our ISOC modeling documentation. Only a start has thus far been made.

Review of Command Costing. We have made a review and evaluation of the costing organization and methodology at the Army's Aviation Command. This has proved quite useful to the Army. We hope to go on to other areas, possibly the Missile Command.

THE RAC MANPOWER STRENGTH AND COST MODEL

Mr. Gilbert Bernstein
Economics and Costing Department
Research Analysis Corporation

Previous attempts in analyzing the impact of alternative civilian and military manpower policies heretofore have been limited to a manual exercise. The serious limitations of this system were:

1. Only a very limited set of alternative policies could be assessed.

2. The interface between civilian and military policies could not be fully appreciated.

As part of an over-all study of military manpower policy by DOD (by Presidential request in April 1964) RAC developed a computerized military-civilian manpower projection model.

This model projects the impact of alternative military and civilian manpower management policies considering a wide range of alternatives including:

1. Continuation of the draft in its present form.

2. Modifying the present structure of the draft.

3. Elimination of the present draft.

4. Changes in force size.

5. Changes in force requirements.

6. Changes in military pay.

7. Changes in military obligation, training patterns and other institutional practices.

The principle outputs of the model include, but are not limited to:

1. Flows of manpower from the civilian and military pools.

2. An annual projection of the age, education, family and military liability status of the male population.

3. A summary of the strength, gains and losses of each of the active duty military components.

4. The costs associated with procuring, training, maintaining and separating military manpower.

This model is now operational and has been used to generate projections for the 1964-1965 DOD Military Manpower Policy sent to the President.

The model has been used already in the Department of Defense and the Army for decision-makers on such alternatives as:

1. Draft married non-fathers.
   (President Johnson's executive order of 26 August).

2. Increase armed forces approximately 20% (Vietnam mobilization).

3. Revise retirement policies.

4. Utilize the draft for the Navy and Marine Corps.

It is now in use and several hundred alternatives have already been exercised in the model.

INDIVIDUAL SYSTEM/ORGANIZATION COST (ISOC) MODEL

Mr. Donald H. Strope
Economics and Costing Department
Research Analysis Corporation

RAC has developed a basic computer framework to be used with various cost models designed for costing a wide range of problems in which systems or organizations are costed in isolation from the total force. This combination of computer program and cost model is called the Individual System/Organization Cost (ISOC) Model.

The ISOC model utilizes a FORTRAN IV computer program designed to rapidly calculate the relative cost of large numbers of military systems or organizations. The basic purpose of the ISOC model is to provide a flexible computer framework (either on an IBM 7040 or 7090) to which any specific individual system or individual organization cost model may be adapted for use in cost studies where a large number of calculations are required and cannot be performed conveniently by hand. A cost model that has been "fitted" to the ISOC model becomes a unique system or organization computerized cost model that may be used for any cost problem requiring its specific design configuration.

The ISOC model is not a single model, but rather is a family of cost models utilizing the same computer framework. This family of models has been used at RAC in several cost studies involving aircraft systems, multi-equipment organizations and missile systems.

The ISOC model is intended to be primarily a tool to develop planning costs in which relative costs among alternatives are more important than the absolute costs. The model normally provides building block costs, although we have introduced time-phasing in a missile system ISOC model. Further applications of time-phasing are planned.

The ISOC model has been designed for relative ease of operation. The principal operator of the model is the cost analyst, not a computer programmer. Little, if any, knowledge of the IBM FORTRAN IV programming language is required.

Because of the importance of sensitivity analysis in cost analysis, this feature has been built into the ISOC program so that in any ISOC cost model the analyst may have automatic changes to his input values in order to test the sensitivity of total system costs to those changes.

Another important feature of the ISOC model is the materiel data library which stores data for up to 300 equipment items. This data consists of average unit costs, maintenance float factors, peacetime replacement factors and combat consumption stockage factors.

The ISOC model has been documented in the following two RAC technical papers. The first one describes the concept and design of the model and provides an example illustrating its use. The second paper is an operator's manual.

RAC TP-183, Volume I, An Individual System/Organization Cost Model: Concept and Application by John J. Surmeier; Unclassified, November 1965.

RAC TP-183, Volume II, An Individual System/Organization Cost Model: Computer Program Design and Operation by Jodie T. Allen; Unclassified, January 1966.

MAIN BATTLE TANK SPECIAL COST STUDY

Mr. F. J. Dahlhaus
Directorate of Procurement and Production
Headquarters, Army Materiel Command

A major challenge to the cost analyst is provided by problems associated with costing a weapon system that is just entering the development cycle. This was the case at the formulation of the Main Battle Tank Special Cost Study.

The objective was to estimate the total procurement costs of the MBT by the preparation of an independent government estimate of the weapon system in support of a Program Change Proposal, and to provide data in support of budgetary requirements and for contract negotiators.

The major assumptions and work breakdown associated with the study are described. A description of the cost collection model is provided, the number of separate estimates from historical sources and engineering estimates identified, the temporary organization within the Army Materiel Command which was established for MBT cost estimating and review, and the series of checks which were performed in the development of the total estimate described.

The paper briefly reviews the major difficulties encountered in the study: first, the changing configuration of a system in early development; second, the problem associated with the assignment of the task of estimating integration operations between mating subsystems; and finally, a summary of results obtained by the organization of the special cost study effort.

COST ESTIMATING BY THE COMPARATOR SYSTEM OF EVALUATION

Mr. Victor Robertson
U.S. Army Missile Command
Huntsville, Alabama

The Comparator Factor exercise is based on numbers which identify differences (or similarities) in the physical or functional characteristics of several missiles. Such numbers are found in various textbooks, engineering handbooks, and other publications.

The initial objective was to determine if costs associated with the various missile components could be described by relationships of the numerical factors which have been assigned over the years to manufacturing materials and processes. Therefore, a considerable number of these factors were made relative to one another with respect to about 15 different existing missiles for which fairly good historical cost data were available. Costs for each of the known missiles were then estimated, using the other known missile Comparator Factors as the basis for "predictions." The "predictions" were then checked against the historical and found to be within a range acceptable, at least for planning purposes, for estimating the probable costs of an unknown, or proposed missile.

This presentation showed a selected and very minor, area of the results obtained, and was primarily oriented toward showing use of actual or known data, tested, first, within itself for results and then for predicting probable costs for a proposed, or future, missile.

This is a continuing project, with the greater part of the work yet to be done.

DEVELOPMENT OF A GENERALIZED HELICOPTER COST ESTIMATING EQUATION

Mr. Norman H. Smith
CEIS Branch
U.S. Army Aviation Materiel Command

The nature of this subject is that of a concept as opposed to a completed or formalized method or equation.

The high cost of military weapon procurement has placed a requirement on the services to improve their cost and management tools.

This study is an empirical method based on historical cost and man-hour data for the complete span of helicopter size and performance characteristics. Data are, for the most part, those collected through AMPR, DCPR and CEIS reports.

Development of this helicopter cost estimating method will encompass all previous and current helicopter models, and will be applicable for estimating the cost of future models based on the requirements of physical and performance characteristics.

As more data are collected and as the state-of-the-arts advance, this method can be updated and refined periodically, and in turn will be more reliable. This method provides a tool for the complete span of management decision-makers from top management for planning, programming and budgeting purposes down to the contract negotiator for new hardware procurement.

ABSTRACTS OF

AIR FORCE PRESENTATIONS

USAF COST ANALYSIS PROGRAM

Major General Duward L. Crow
Director of Budget
Headquarters, U.S. Air Force

Cost analysis began on the sideline of military affairs. It is now ready to take its rightful place in the fabric of the day-to-day business of the Department of Defense. In fact, this last step, the complete integration of cost analysis as an inextricable function in the decision-making process, may be the most difficult of all.

The first step is to define the function; what is cost analysis? I dare say each of us would give a slightly different answer to that question. The procurement specialist would say that verification of contractor cost estimates and pricing negotiations is cost analysis. The budget officer feels cost analysis to be the generation of factors for budget justification. The programmer would have neither of these definitions. He would relate cost analysis to the estimation of the costs of entire systems. The professional analyst thinks of the subject as being composed of relationships between independent and dependent variables, historical data, learning curves, regression analysis, etc. He also knows that all of the estimation activities I have mentioned are cost analysis. The fact that some fail to recognize the more scientific methods of the professional analyst is part of our job. Cost analysis is the foundation on which we must support all of these estimating requirements. Now we are able to define cost analysis as the method of predicting prices and costs using a proper balance of carefully examined historical data and the application of the scientific methods of estimation.

Organization is the second step. We are all familiar with the span of control and its diagrammatical pyramid. It has been my observation that the cost analysis pyramid is inverted. The work of too few analysts is being directed and examined by too many reviewers. We really must correct this quality stifling organization as a first order of business. In the Air Force, we have a remedial program in progress.

Point number three is fiscal administration. The first thing we need here is a term which is more descriptive than the one I used. What I am talking about is a cradle to the grave tracking of costs by system or item. A formal documented tracking system is now being used by AFSC. I really can not overestimate the importance of this point. It is a long way from the estimator in the SPO to OSD and back. Sometimes estimates are changed by review authorities for a legitimate reason such as a change in design. Ultimately someone has to explain

the change in the total. Obviously he would be hard pressed to do so without a record of the reviewer's change I have just described. Congress has become more impatient in recent years over our justifying funds for one purpose and spending them for another. This is another unhappy outgrowth of our inability to pinpoint the various elements in a system estimate. We are on our way to solving this problem, too.

This leads to the last of my four points. All of us, the Services, OSD and the non-profit contractors have devoted most of our cost analysis capability to the more glamorous elements of our total program, the space systems and the major weapons systems of the present and the future. We have neglected the areas where we spend the most money, operations and maintenance, spares and other support. We all need to improve such mundane and obtainable factors as cost of spares and maintenance, by flying hour by type of aircraft. A great deal of work is called for in the operational support and training areas.

USAF COST MODELS: OPERATION AND RESEARCH

Mr. Kenneth Conley
Chief, Cost Analysis Branch
Cost Division, Directorate of Budget
Headquarters, U.S. Air Force

Air Force computer cost models are of three types: those dealing with complete force structures, individual weapon systems, and some portion of a weapon system.

The total force model is called SABLE, an acronym for Scientific Approach to Better Long-Range Estimates. It was designed to provide time-phased, relative costs of alternative force structures. Different routines are provided for aircraft systems, missile systems and electronic systems. The majority of the inputs are by weapon system. The output is designed to be compatible with the Force and Financial Program at the levels of Program Element, Cost Category, Major Program and Appropriation.

Second of the three types of models is that which is confined to a single type of system. MOOSE, an acronym for Model for Obtaining Orderly Systems Estimates, produces non-time phased or "static" estimates or research and development, initial investment, and a specified number of years of operating costs. Separate models have been developed for an aircraft and a missile system.

The third type model is used for examination of one aspect of a weapons system. AERO, acronym for Airframe Estimates, RAND and OSD, produces airframe cost estimates based on physical and performance characteristics of the aircraft.

Additional research is underway. A new model, APEX (Automated Program Exercise) will automate Air Staff programming processes. Existing models are being improved through new methods and procedures, more flexibility and sensitivity, additional automation to improve performance, and interface between the cost models and the planning, programming, and budgeting financial systems.

USAF COST ESTIMATING RELATIONSHIP/COST FACTORS PROGRAM

Mr. Riner C. Payne
Chief, Cost Factors Branch, Cost Division
Directorate of Budget, Headquarters, U.S. Air Force

Communication between individuals with respect to the USAF Cost Estimating Relationship Program is dependent upon acceptance of the same basic definition. We define a CER as a mathematical statement of the relationship between one or more independent variables (activities, program levels, characteristics, etc.) and the dependent variable (cost).

Coverage of the USAF CER Program is currently limited to the Operation and Maintenance Appropriation. Dollar data are based primarily on a historical recording of obligations. These data are accumulated at base level along with net value of supplies and equipment issued by organization. At major command level this information is identified with applicable program elements shown in the DOD programming system. Each major command is encouraged to associate appropriate independent variable information (such as flying hours, number of officer authorizations, etc.) with the dollar data accumulated as described above. Appropriate statistical techniques -- primarily regression analysis -- are applied to determine whether a valid estimating equation can be established. CER analyses deemed acceptable by the major commands are provided to Headquarters, USAF for validation and/or application in other major commands. When substantial coverage of the O&M Appropriation has been effected, the approved CER's will form the basis for command projections by program element and cost element for the Five-Year Force and Financial Program. (The CER Program is outlined in Air Force Regulation 173-2 dated 21 September 1965.)

The CER Program was initiated on 1 July 1964. Most major commands have developed an acceptable data base. A sample report was received covering six groups of object classes for FY 1965. The first draft of a manual prescribing a Standard Major Command CER Data Base was recently completed. This manual will be finalized prior to 1 June, and its implementation directed beginning with Fiscal Year 1967.

While not officially identified as part of the USAF CER Program, the Air Staff, the Air Force Systems Command, and some non-profit contractors have produced CER's pertaining to development and procurement of the major weapon systems. Plans are also being formulated to extend the coverage (now limited to the O&M Appropriation) of the USAF CER Program to encompass all operating costs. The Assistant Secretary of the Air Force has directed that an integrated CER Program covering development, investment, and operating costs be developed.

ROLE OF AFSC IN COST ANALYSIS

Colonel Jack B. Henderson
Director of Cost Analysis
DCS/Comptroller, Hq Air Force Systems Command

Any cost management improvement program should, and the AFSC program does consider the program manager's daily challenge on the one hand, and the Commander's requirement to have alternatives evaluated with a cost consideration, on the other. Among the requirements for estimates and re-estimates on a continuing basis, therefore, are those of procurement, systems management, and programming functions, as well as those required in anticipation of the phase-out of certain programs and the introduction of new ones. Any planning or decision-making is necessarily limited by the confidence the decision-maker can place on the ingredients of the plan. Thus, a credible cost estimate, i.e., one in which the decision-maker can have confidence at the time the decision needs to be made, plays an important part in cost management in the OSD environment.

To accommodate this requirement, the Systems Command asked, in January, 1964, a firm of management consultants to review its cost management procedures. On the basis of the contractor's findings and recommendations, the existing Command Cost Analysis Program was expedited and a Task Force was established to accomplish the indicated improvements. Standard estimate documentation procedures were developed, uniform estimate tracking procedures were established for use throughout the Command (and are now required by USAF), assistance was given to the establishment of a DOD-wide, responsive, compatible cost information procedure, and appropriate organization, staffing, and training were recommended to carry out the procedures and build the credibility base. These recommendations resulted in the approval of a PCP, providing 149 additional spaces for the Command cost analysis program, and in a three-part organizational configuration for each cost analysis office at Headquarters and the Divisions to:

- perform the estimating responsibility.
- provide an improved data base (also responsible for estimate tracking).
- update methods and procedures.

We are now recruiting in an enthusiastic, business-like manner, looking for and intending to obtain - or grow - quality. In the interval, we are implementing with existing capability. We must implement, we must apply the procedures if we are to refine them with the lessons learned. It is from these steps that our estimating credibility base will be improved so that we will be deserving of the Department of Defense confidence.

RESEARCH ON A FRAMEWORK FOR TOTAL FORCE STRUCTURE COST ANALYSIS

Mr. Brent D. Bradley
Cost Analysis Department
The RAND Corporation

This discussion deals with some recent thinking about the nature of force structure cost analysis for Air Force planning studies. It describes a research framework being devised to implement a new costing model to replace the existing RAND force structure cost analysis model, PROM. Two facets of force structure analysis are central to the research framework: the provision of time-phased cost inputs to the systems analysis/cost-effectiveness process; and the gross measurement of the resource implications and feasibility of planning proposals by dealing explicitly with individual resources.

The research on the new model is emphasizing the identification of critical resources and constraints (an illustration concerning manpower skills is given) and a more thorough understanding of non-combat and support activities in the Air Force. Identification of critical resources is a necessary step toward measuring resource feasibility. The concern with non-combat and support activities stems from their importance as integral parts of system cost studies, the loci of many factors critical to resource feasibility, and their intrinsic importance as consumers and generators of resources. One intention in the emphasis given to these activities is to increase the options available to force planners in manipulating institutional and policy variables as well as weapon systems -- that is, the ability to compare maintenance, basing, training and other alternatives in addition to force posture alternatives.

Structurally, a comprehensive framework has been devised to define and describe the existing Air Force and provide the basic input-output format of a new model. The framework is described as consisting of three major dimensions: programs and program elements patterned after the Air Force Force and Financial Program; appropriation oriented cost elements for displaying dollar costs; and computational sub-models for translating program element requirements into the manner in which estimates are made. A key feature of the program element structure is the categorization of all elements -- including those of Program VII, General Support -- into Mission, Command Support, and Installations.

The framework as described is used to guide research on both the content and requirement of individual program elements and the computational methods and submodels for estimating resources. An example is given of research in the Technical Training program element to determine its resource requirements and constraints. A further illustration is given concerning the relationship of program element research to the computational submodels, using the recently completed aircraft procurement model as an example.

SOME METHODOLOGICAL PROBLEMS OF AIRFRAME COST ESTIMATION

Mr. Stephen M. Barro
Cost Analysis Department
The RAND Corporation

During 1965 studies on cost estimating relationships (CER's) for military airframes were completed by The RAND Corporation, the Center for Naval Analyses (CNA), and the Planning Research Corporation (PRC). There are some significant methodological differences among the three studies. Some of these differences are discussed here, not merely with reference to airframe cost estimation, but in order to illuminate methodological issues that are relevant to a broad variety of cost analysis problems.

First, there is the question of how many explanatory variables should be included in a CER. Three criteria for the inclusion of variables are stated: theoretical relevance, statistical significance, and independence. It is concluded that the existing cost data base can support simultaneous inferences about the effects of only a few variables, and that inclusion of extra variables, as in the PRC study, is undesirable.

Another question is whether a particular variable should be treated by regression or nonregression techniques. Treatment outside of the regression framework may be appropriate when there is either extra information or a special lack of information about the effects of the variable, or when subjective adjustments are to be applied to the data. The disadvantages of a nonregression treatment are that the total estimating error of the CER is difficult to calculate and that information about interactions among variables is not available.

The question of how to treat interdependent variables is an especially difficult one when one of the interdependent variables is time. In the CNA study, intercorrelation of time with maximum aircraft speed leads to an unreasonably low estimate of the effect of speed on airframe cost. Special analytical techniques other than regression analysis are needed to discriminate between the time and speed effects. From the RAND work it appears that the observed time trend is due to an increase in overhead relative to direct costs. However, the RAND study avoids the problem by subsuming the time trend in the factor that is used to convert labor hours into dollars. The user is required to provide his own conversion factor for future years and is thus left with an incomplete procedure for estimating dollar costs of new aircraft.

The most conspicuous differences among the three studies have to do with their handling of cost-quantity relationships. The three procedures agree in specifying log-linear cost-quantity curves, but they

differ about how the slopes of these curves should be estimated. The CNA and RAND procedures provide constant slope values to be used for estimating costs of all new airframes. But CNA's constant slope value is estimated from a regression equation, while RAND's is obtained as an average of slopes observed for individual sample aircraft. Each method has some statistical shortcomings.

The PRC method, on the other hand, provides regression equations for cost at four standard production quantities. A cost quantity curve is then fitted through the resulting four points. This method is claimed to provide for systematic variation in slopes from one aircraft to another. However, there is no evidence that the variation in slopes among aircraft is really systematic, nor that slope values are estimated more closely by the PRC "four point" procedure.

A simultaneous equation estimating technique derived from econometric theory may be of value in overcoming the statistical difficulties in the three cost-quantity procedures, and in resolving the issue of constant or variable slope.

ABSTRACTS OF

NAVY PRESENTATIONS

COSTING IN THE DEPARTMENT OF THE NAVY

RADM E. E. Grimm
Director of Budget and Reports
Office of Comptroller of the Navy

The importance attached to cost data and the concept of costing itself have undergone major change in Navy in recent years. Complete, accurate, timely cost data is a necessity in today's management environment. Cost data has therefore become a key element in the management process and is being used increasingly in such matters as long range planning, programming, budgeting, funding, cash flow, program management, and cost control.

Yet, in spite of advances, much remains to be done. The future holds great promise, however, and the Navy is on the threshhold of major advances in the costing field. This will come about with development of the DOD resources management system.

In the Department of the Navy, the Assistant Secretary of the Navy for Financial Management is responsible for costing. The necessity to give increased management attention to the costing functions has been recognized by the Assistant Secretary, and he has directed that a separate costing organizational unit be established within the Office of Budget and Reports.

Until recently, the Navy had not given sufficient attention to the area of total costing. This deficiency has now been materially overcome with implementation of two systems -- the Navy Cost Information System and the Navy's cost model. Development of the Navy Cost Information System has been a major undertaking of the Office of the Comptroller during the past five years and represents a significant forward step in providing a necessary costing capability for use in both the programming and budgeting process. The second significant system -- the Navy's cost model -- is used to price out alternative forces on a rapid response basis using cost factors.

Costing represents an area to which greater attention must be given, and more resources devoted. This is exactly what the Department of the Navy proposes to do in the months ahead.

NAVY COST INFORMATION SYSTEM

Mr. D. L. Jackson
Director, Progress Reports and Statistics Division
Office of the Navy Comptroller

The Navy Cost Information System (NCIS) is an ordered discipline whereby data are organized to produce multi-faceted pre-designed relationships.

The methodology is that of building one over-all Navy-wide system using the Bureau, Office and Headquarters Marine Corps cost data systems as its building blocks. This approach insures accurate data and develops an inherently integrated total Navy-wide system.

The system is capable of portraying the total Navy Program/Budget and can automatically validate and measure progress against plans, programs and expenditures by feedback from the Navy Cost Accounting System. The design permits the reflection of resources cost data from a variety of angles, such as cost by mission, function, Program/Budget, forces, naval activities, etc.

Our current efforts are directed at the development of a common systems language to be used internally within the Bureaus, Offices and Headquarters, Marine Corps with adequate controls and timely input to a Navy Master Data Bank.

NAVY COST MODEL

Mr. Culbert Laney
General Planning and Programming Office
Office of the Chief of Naval Operations

The Navy Cost Model has evolved over a ten year period, starting at first as a relatively unsophisticated effort by four analysts in the Office of the Chief of Naval Operations. The model provides rapid estimates of the dollar and manpower requirements to support alternative sets of Navy forces. This is done by using an assembled set of Navy program factors and a computerized set of cost estimating relationships to compute statistical averages. This contrasts to the collection of budget detail through the Navy Cost Information System.

The model provides three views of dollar estimates. The first is by fleet item, e.g., ships by class, aircraft by model, missile by class, shore activities by type. The second is by DOD program and program element. The third is by budget appropriation, including the three cost category groupings of Research and Development, Investment and Operating.

The four basic steps in developing the model were: First, determining the basic building blocks; ships by class, aircraft by model, missile by type, other hardware such as Mark 46 Torpedo, and Shore Establishment by type of activity. These comprise 638 basic program units for all five types of building blocks. Second, the possible assignments or uses of these program units were considered, such as ships assigned to Active Fleet, Naval Reserve Training, Military Sea Transport, Service Craft or Miscellaneous assigned; and Aircraft assigned to Navy Combat Units, Marine Combat Units, the Naval Air Reserve Training Command or to other units. Costs differ according to assignment. The third step was developing the cost estimating relationships. The fourth step was the development of a computer program to do the arithmetic and produce desired outputs.

Model uses include costing alternatives for the Joint Strategic Objectives Plan, costing and publishing Navy Program Objectives, and providing costing services for Navy and OSD studies

CNA COST ANALYSIS ORGANIZATION and HIGHLIGHT OF RESEARCH

Mr. W. D. Weir
Head, Cost Analysis Division
Center for Naval Analyses

The primary mission of CNA, put briefly, is to participate in the Navy's study and analysis effort. The Cost Analysis Division, a part of the Systems Evaluation Group, devotes a large fraction of its efforts to support of systems analyses conducted by the Naval Warfare Analyses Group.

These systems analyses are usually concerned with mission area force level and structure. The mission areas may involve systems which are primarily naval as is the case in ASW, Amphibious Warfare, and Fleet Anti-Air Defense studies. In other areas such as Tactical Aviation and Airlift/Sealift, however, systems from the other services may be of major concern in the studies.

The time available to the Cost Analysis Division for research is severely limited by the need to support the NAVWAG studies. On the other hand, the research program benefits from close contact with those problems which are of current and major concern in DOD decisions. Typical of the problems which frequently arise and need additional research are the following:

Ship Life - involves questions of remaining value, inherited assets, discounting.

Multiple Missions - concerns joint costs and spill-over benefits.

Auxiliary Uses - may require estimates of peacetime "earnings."

Mission Areas vs Individual Weapon Systems - applicable categories, particularly in the support activity areas, and level of detail have to be determined.

The research undertaken in CNA is often in response to problems encountered in NAVWAG studies. Not all the research is done by the Cost Analysis Division. Some is carried out in other elements of CNA, as can be seen from the following list of projects which highlight the research that has been performed recently in CNA.

Escort Ship System Cost Analysis (SEG-RC-2) - develops CER's from a statistical analysis of escort cost data.

Alternative Ship Production Schemes (NWG 51-66) - examines effects of various actions on contractor incentives to invest in production facilities.

Airframe Cost Analysis (INS-RC-9) - concludes that a major explanatory variable is time trend, made up of inflation and advances in technology.

Support Activity Cost Estimating (SEG-RC-3) - identifies cost generating functions for personnel, aircraft, and ships.

Evaluation of Non-Marketable Assets (CNA-RC-15) - concludes that discounting is meaningless for most defense analyses.

Concepts and Techniques for Summarizing Defense System Costs (SEG-RC-1) - describes and compares five techniques, generally indicating a preference for present value methods.

In trying to anticipate the requirements of future studies, several areas can be identified now in which research would be beneficial. Projects will probably be started in these and other areas as the time becomes available.

Elements of ASW systems, particularly data collection and processing.

Advanced ship concepts such as surface effect ships.

Air defense and shore fire support shipboard weapons systems.

Operating and support activity costs.

Trans-oceanic transportation.

HIGHLIGHTS OF NAVY COST RESEARCH PROJECTS OTHER THAN THOSE OF THE CENTER OF NAVAL ANALYSES

Captain L. P. Daniels
Head, Contract Information Branch
Office, Chief of Naval Material

In the personnel field we have had a number of cost studies. The result has been to increase our knowledge about the cost of personnel. Typical of these studies are the following:

1. Enlisted personnel replacement costs in the rates of (BM, FT, MT, RM) -- completed in February 1964.

2. Personnel costs for ten selected ratings -- completed April 1965.

3. Officer personnel costs showing separate costs for officers procured through four separate programs.

   a. Naval Academy
   b. NROTC
   c. Aviation Officer Candidates
   d. NAV Cadet Program.

4. A study on the Methods and Problems of Computation of Enlisted Personnel Costs. This first study was printed in February, 1964. There is additional work now being carried out in this area and a continuing program is planned for the future.

In the personnel field the cost effectiveness of man-machine trade-offs requires some valid answers. The personnel cost studies I referred to previously have provided a basis for approaching the real pay-off which is the development of man-machine trade-off formulae for application to cost effectiveness studies.

One project of this type has been completed. It covers personnel costs for use in ASW Surface Ship Systems cost effectiveness comparisons. It has limited application in this field.

To develop additional information on this subject the Navy, under the Bureau of Naval Personnel, has a continuing study program underway. The concept of this study is a data bank with systematic cost inputs. Essentially, this is a matrix of costs from which formulas will be developed for the comparison of man and machine costs to determine or to validate the allocation of those functions which can be effectively performed by either man or machine.

The field of aircraft operating costs has felt the need for cost effectiveness studies. There is a current study underway by BUWEPS to refine the planning factors for the operation and maintenance of transport aircraft. The purpose of this project is to analyze historical operating and maintenance cost data on Navy transport aircraft and to develop equations for predicting costs for current and future aircraft. Completion is estimated in June 1966.

The production of rapid cost estimates is needed for future operations.

The Bureau of Ships plans to award a contract for the purpose of developing a verified technique for rapid estimating of ship end cost by use of a computer program. This is a future planned action and is not yet under contract.

ESCORT SHIP SYSTEM COST ANALYSIS

Mr. R. P. Caldarone
Cost Analysis Division
Center for Naval Analyses

Cost estimating relationships are developed for estimating the system costs of surface ship escort types for use in cost-effectiveness studies. Included among the CER's, are relationships for estimating the ship investment costs, ship class lead costs, initial training costs, initial ordnance and missile costs, and annual operating costs.

Most attention in the paper is devoted to the ship investment cost relationships. Statistical cost analysis techniques are applied to historical U.S. Navy surface ship escort cost data in developing the investment cost relationships. The data base includes all post World War II escorts through the program year 1964 for a total of 122 data points. Variables such as the displacement, installed shaft horsepower, sustained speed, unit quantity, time, and dummy variables for nuclear and diesel technology and weapons and electronics complexity are used in the investment cost relationship.

Finally, the CER's are combined with equations relating physical characteristics to effectiveness measures such as payload weight, sustained speed, and endurance for illustrative purposes.

CNA publication SEG(RC)-4, "Escort Ship System Cost Analysis," 11 February 1966, Confidential, describes this project in greater detail.

P-3A UTILIZATION AND SUPPORT SYSTEM REQUIREMENTS STUDY

Mr. Donald H. Sunde
Technical Director, Weapon Systems Analysis Office
Bureau of Weapons, Quantico, Virginia

The P-3 is currently replacing the P-2 as the Navy's primary ASW patrol aircraft. As an aid to developing future plans for the aircraft, Weapon Systems Analysis Office (WSAO) was requested to study the utilization of the aircraft under emergency and wartime conditions and to provide a method and inputs for establishing P-3A Force and support system levels which satisfy specified wartime operational requirements at minimum lifetime investment and operating costs.

The solution involves a detailed simulation (programmed in Simscript for an IBM 7090 computer) of the maintenance and operations activities of a squadron of aircraft over a specified period of time. For given levels of support resources and aircraft in the squadron, its capability to meet each of a range of sortie levels under peacetime, emergency and wartime environments is established.

On the basis of lifetime investment and operating costs of the systems, costs per effective sortie flown in response to the given demands are plotted. These plots provide the basis for establishing optimum force and support system levels at any combination of peacetime, emergency, and wartime flying requirements.

ABSTRACTS OF

OSD PRESENTATIONS

OSD COST RESEARCH: INTRODUCTION AND OVERVIEW

Mr. Saul Hoch
Director, Cost Research and Analysis
OASD (SA) - Resource Analysis

This presentation describes the organizational placement and major functions of the Directorate of Cost Research and Analysis and a brief statement of other costing activities in OSD. Three major functions are discussed -- research in cost estimating methodology, participation in the annual force review and special studies. With respect to the first, cost research has thus far emphasized the investment area; a need for further research in the field of operating and support costs is becoming urgent. It is the aim to sponsor work leading to improved cost analysis tools in all areas and to distribute research findings throughout DOD.

The discussion of the second function includes a background description of the force review process. The need for rapid, but reasonably accurate, costing response for weapon systems planning has placed an emphasis on the development of meaningful cost factors and cost estimating relationships. The need for continued review and improvement of such factors and relationships so as to be available during force reviews is felt to be the major need in cost analysis for force planning purposes.

STATISTICAL COST ESTIMATING RELATIONS - SOME BASIC ISSUES (AIRCRAFT EXAMPLES)

Mr. Harry P. Hatry
Directorate of Cost Research and Analysis
OASD (SA) - Resource Analysis

This presentation discusses briefly some of the basic issues of statistical CER's. These include:

a. The major characteristics of statistical cost estimating relations (CER's),

b. Where and why they are used, and

c. Some of the major problems in their development - including problems associated with the choice of the dependent variables, choice of the independent variables, choice of the form of the equations, the handling of the input data, and the evaluation of the resulting relation's prediction capability.

The major recent aircraft cost research studies sponsored by OASD (SA) - Resource Analysis are briefly described. These include:

a. The fixed-wing airframe procurement cost study (undertaken by the Planning Research Corporation, PRC),

b. The large transport study (performed by PRC and OSD),

c. The commercial supersonic transport cost analysis (undertaken by Operations Research Inc. and PRC for the Department of Commerce but monitored by OSD),

d. An experimental in-house study on CER's for transports (which attempts to estimate directly total aircraft flyaway as a function of over-all mission performance capability), and

e. The helicopter procurement cost study, an in-house project currently in process.

In addition, the lack of existing statistical CER's in such areas as avionics and aircraft operating costs is indicated.

The presentation concludes with a summary of the major advantages and disadvantages of the use of CER's for cost estimating.

This presentation is documented in OASD (SA) Publication TP 66-3.

COST ESTIMATING RELATIONSHIPS FOR MISSILES AND RELATED SUBSYSTEMS

Mr. Keith E. Marvin
Directorate of Cost Research and Analysis
OASD (SA) - Resource Analysis

This presentation illustrates the substantially different analytical problems involved in developing cost estimating relationships for flyaway missile costs as contrasted with costs of the variety of command, launch and flight control subsystems to be found in the various missile systems. The flyaway missile cost situation is illustrated using Minuteman missile subsystem costs. The command, launch and flight control cost situation is illustrated using a description of Nike-X radar subsystems and the major cost generating parameters associated with each of these subsystems. The effect on costs of substantial production rate changes is illustrated, using examples from a recent joint DOD/NASA study of space launch vehicle costs.

Although statistical techniques applicable to missile flyaway costs are similar to those used successfully for aircraft flyaway cost estimating relationships, there are important differences in the breakdown structure and in the type of cost data available. The reasons for this are discussed and it is concluded that there would be relatively greater difficulty now in reconstructing actual contract costs for missiles as we have done for many aircraft. As an alternative, it appears feasible and worthwhile to develop approximate actual flyaway costs by analysis of fiscal year budget back-up data which is available from all three Services. A study of this nature, being conducted for OSD (SA) by Planning Research Corporation, is described briefly.

The estimation of Nike-X radar costs is characteristic of the nonflyaway portion of many missile systems in that many subsystems are unique to a particular missile system. Phased array radar cost estimating relationships have been developed for OSD (SA) by Columbia University Electronic Research Laboratories. These were developed essentially from more detailed cost estimating techniques used by leading contractors in design cost optimization studies. This radar cost study presents an approach to the development and documentation of cost estimating relationships for items whose characteristics are not comparable to those for which we have actual costs.

This presentation is documented in OASD (SA) Publication TP 66-4.

STATISTICS IN COST PREDICTIONS AND POTENTIAL

Mr. Harry Piccariello
Directorate of Cost Research and Analysis
OASD (SA) - Resource Analysis

The business of cost estimating is prediction. The problem is we do not know when we have a good predictor. The use of normal regression theory in determining cost estimating relationships permits probability statements (prediction intervals) about the worth of the relationship as a predictor. The problem of finding prediction intervals for total costs is compounded by the fact that in general the component costs (e.g., tooling, material, labor, engineering) are estimated separately. This problem can be coped with by estimating totals directly. Another problem not so easily solved is that the prediction intervals have little meaning if the functional relationship between costs and physical performance variables is unknown. This paper discusses these problems and some possible approaches to the prediction problem in cost estimating.

This presentation is documented in OASD (SA) Publication TP 66-5.

COSTING GUIDELINES AND COST HANDBOOKS

LCDR M. Staser Holcomb
Directorate of Cost Research and Analysis
OASD (SA) - Resource Analysis

The necessity for timely establishment of guidelines for costing of weapons systems in cost-effectiveness and requirements studies is discussed. The major features of costing guidelines are examined. Examples of significant accomplishments on the part of OSD in this area are presented.

Recognizing that the volume and dispersion of weapons system cost data and estimates leaves the systems analyst without a tool for rapid and rough cost estimating, the compilation of "cost handbooks" is discussed. Two examples of handbooks prepared by OASD (SA) - Resource Analysis -- a Navy Cost Handbook for Ships and Aircraft and a NIKE-X Cost Handbook -- are presented. The limitations and capabilities of such compilations are summarized.

This presentation will be documented in OASD(SA) - Publication TP 66-6 in the near future.

DATA SYSTEMS DEVELOPMENTS

Colonel Herbert Waldman
ent Systems
OASD (C) - Management Systems Development

The information revolution has caused the creation of a wide variety of systems -- but cost estimating remains a problem because of data Deficiencies have appeared in estimates of poor quality in acquisition programs; these cases have motivated attempted improvements which recently have resulted in the Cost Information Report, CIR, developed jointly by ASD Comptroller and Systems Analysis CIR consists of five forms on which aerospace systems contractors initially will report data. The reporting requirements are now being cleared with the Bureau of the Budget and implementation will begin during April 1966 and expansion of CIR coverage will occur thereafter

Copies of the presentation are available from OASD(C) - Systems Development.

DEPARTMENT OF DEFENSE COST ANALYSIS COURSES

Colonel Troy Jones
School of Systems and Logistics
Air Force Institute of Technology

The Department of Defense sponsors two Cost Analysis courses offered by the School of Systems and Logistics, Air Force Institute of Technology, Wright-Patterson Air Force Base, Ohio, as follows:

Number	Course Title	Length
Course 189	Quantitative Methods in Cost Analysis	9 weeks
Course 191	Advanced Cost and Economic Analysis	7 weeks

Course 189, offered to military and civilian cost analysts of the military departments and OSD, is designed to develop the quantitative skills required by cost analysts engaged in any aspect of cost estimating and analysis relating to weapons or forces development, acquisition or operation. The scope of the methods taught extends from simple algebraic and statistical techniques to measurements involving calculus and multiple regression.

Course 191 is an "applications" course which builds on the quantitative methods provided by Course 189. It is designed to provide cost analysts of the military departments and OSD with a comprehensive understanding of the skills and techniques required to prepare independent estimates of the costs of total or partial weapon or support systems, forces, or proposed courses of action. Throughout the course emphasis is on developing judgment through applying skills in the solution of actual and hypothetical cost problems.

In addition to the above courses, the School also offers the following related courses in its Continuing Education Program:

Number	Course Title	Length
Course 196	Cost Information Reporting System	3 days
Course 198	Cost Information Reporting - Government/Industry Orientation	1/2 day
Course 192	Evaluating Contractor's Estimating Systems	4 weeks

Additional information concerning these courses may be obtained from the Defense Logistics Management Training Catalog, DOD 5010.9-C, 1 November 1965, or from OASD (Systems Analysis) - Resource Analysis, or from the School of Systems and Logistics, Wright-Patterson Air Force Base, Ohio.

CLOSING REMARKS

Harold Asher

Also Published as
OASD - Systems Analysis Paper TP 66-2

CLOSING REMARKS: SUMMARY AND PLANS FOR THE FUTURE

Harold Asher
Deputy Assistant Secretary of Defense
OASD (SA) - Resource Analysis

I believe we would all have a greater feeling of accomplishment from planning and attending this Symposium if we now were to take some steps to exploit this modest beginning. I would like to propose, therefore, several such specific steps as well as a rather general one that we should take during the remainder of the year.

The first deals with the Cost Research Survey which has been distributed to most of you. We in OSD have found this to be a valuable source book and I believe other components of the DOD will find it equally so. In view of this initial success, we are now proposing to publish a Survey periodically, possibly annually. We will, of course, try to improve both the format and the content of the next issue. We have thought of at least three improvements already. First, it would be an easier document to read if each of the entries were prepared in a more nearly similar format or outline. Second, the entries for some of the studies are not sufficiently descriptive while others are somewhat lengthy. And third, each entry should be specific as to the status of the project being reported. We shall try, in the future, to provide better guidelines to those of you who will be supplying the inputs to the Survey in order to make it a more readable and informative document.

As you know, the Survey covers those cost research studies "whose results are intended to be applicable to more than a single, immediate, cost investigation." We are aware, however, that in many force or requirement studies dealing with specific weapon systems, where cost is a part of a larger examination, cost estimating techniques may be developed that are, in fact, applicable to a wide range of systems, and not only to those included in the force or requirement studies.

For example, we recently completed a C-5A study in which statistical cost functions were developed that seem to have application not only to the C-5A but to a rather wide range of transport aircraft. In such cases, it would be desirable if the results of these cost research activities were abstracted in a separate document, included in the Survey and made available for distribution separately from the broader study of which it was a part.

A question we have not yet resolved has arisen with respect to distribution of the Survey document. As you know, the document is unclassified and hence, at least in principle, available for distribution outside the Department of Defense. Whether future editions of the Survey should be retained within the DOD for "Official Use Only" will be decided on the basis of the difficulties created by the present unrestricted version.

In addition to periodic surveys of cost research studies recently completed and in process, we believe we need a bibliography of studies completed during the past several years. The present Survey document will become too large and unwieldy if both "in-process" and all completed studies are included. Hence, we shall, in conjunction with future surveys, publish such a bibliography of completed cost research studies.

It is gratifying to find that the quality and quantity of cost research in the DOD has increased so dramatically over the past few years. However, as impressive as this effort has been, it is dwarfed by the work yet to be done. To continue this progress, we (the three departments and OSD) will need more and better data reflecting actual costs of R&D, procurement and operations; we will need the proper analytical organizations established or strengthened, and finally -- and most important of all -- we need qualified people to perform the analysis of these data. Without adequately trained and motivated analysts in these cost activities, the effort we will expend in acquiring the necessary data and creating cost analysis organizations will have been wasted.

There are two facets to this personnel question. First, many of these cost analysis offices are already staffed by people who have had a wide variety of backgrounds. For those who aspire to do analysis of the kind demonstrated here over the past two days, I believe it essential that they either have the mathematical or statistical skills when they are assigned to these offices or that they acquire such skills without delay. It was for such people that our introductory course in quantitative methods was established at AFIT. As one would expect, not all of the right people have been sent to the course thus far. I would like to urge those of you who are in need of this kind of training, or in need of brushing up some previous training, to volunteer to attend a future offering of this course. Incidentally, I would like to congratulate Dr. Kroeker, Colonel Jones and the AFIT faculty for the substantial effort that has gone into the development and the presentation of this course.

We do not view this course as a substitute for a regular college program in statistics and mathematics. Although it is equivalent to a college quarter of work, the topics covered in it would ordinarily be presented over, at least, a two-year period in a college program.

Therefore, each topic must be dealt with at AFIT in an abbreviated manner. However, we view this course as a minimum exposure required in order to do the kind of analysis we are seeking in the DOD. If this course motivates a few of you to supplement this course with a regular course at a local university, the DOD will be better off for it -- and so will the few who do so.

So much for the course at AFIT. I would like to appeal to those of you who are asked to supply names for the AFIT course -- please send only those whose future jobs will require such training. It may be painful to lose some of your key people for 9 weeks, but I am sure that their greater productivity, after having attended the course, will more than offset this initial investment.

The second facet of this personnel question deals with the recruiting of new personnel. Mr. Vance recently approved a total of about 300 additional spaces for the Air Force and the Navy to strengthen the cost-analysis programs of these two Departments. The Army has, for the time being, apparently found a sufficient number of available spaces from within its authorized strength to devote to its cost analysis activities. The question now is what kind of recruiting program has been organized to attract capable people into these new jobs. I confess to knowing next to nothing about the art of recruiting -- hence, I feel free to discuss the matter. It is my general impression that we do not have a recruiting program that is powerful enough to acquire the talent required for these spaces. It seems to me what is needed is an aggressive, imaginative recruiting program aimed at both fresh University graduates as well as at individuals currently employed in industry, in management consulting firms and in contract research firms. We need not be modest with respect to what we can offer these people in salary as well as interesting work. I believe we have, over the past few years, become quite competitive salary-wise with industry. And what is equally important, I firmly believe that we can offer much more exciting work than can industry, largely because our work is broader in scope and provides access to more information than is normally found in this type of work in a single company in industry. Unfortunately, however, the message as to the attractiveness of this type of work in the Department of Defense is simply not being put across at the proper places and to the proper people.

To help us deal with this recruiting problem, we have asked for the assistance of the individuals in each of the Departments who are responsible for recruiting. We have asked them for information that will indicate (1) whether the new spaces that have been approved for cost analysis work in their Departments are being utilized for the purpose intended, (2) whether we are getting properly trained people for these positions, and (3) what plans have been made to fill the remaining positions. It is with respect to the last point, i.e., recruiting plans, that we are most concerned.

I am proposing that we undertake a DOD-wide recruiting program to fill these spaces in the Departments as well as a few we have open in Mr. Hoch's office and in other DOD agencies. This recruiting program will be aimed at both University students (preferably those completing their degrees this June) and at indiviauals currently employed in industry. We are now planning to write a Madison Avenue-type brochure that will, in reasonably technical language, describe to prospective candidates the kind of work we are doing and the opportunities they will have to advance their careers in this work. We shall carefully select Universities where we can deliver talks to the eligible students and discuss first hand with them these opportunities. We would welcome volunteers from the cost analysis offices of the three Departments to share with us assignments to visit some of the Universities.

We will organize the campaign to attract industry people after we have this University program underway since we have very little time to talk with the June graduates. We still have much work to do in carrying out this recruiting program. I am convinced it is needed and those of you who are in charge of cost analysis offices and must find eligible candidates for your offices I am sure will agree with me. I feel we really have no alternative but to launch this type of effort. We will be grateful for any help you can give in this program. We will continue to work as a committee with the civilian recruiting offices of the Military Departments.

Another step we would like to take in the near future is to establish a DOD Cost Analysis and Research Committee. The functions of such a committee would be to (1) plan future symposia on an annual basis, (2) provide a mechanism throughout the year for interchange of ideas, (3) help structure the DOD-wide cost research effort to avoid unnecessary duplication and encourage research where needed, and (4) provide a forum for discussing technical questions in the cost analysis area.

We would like to convene such a committee, chaired by Mr. Hoch, within the next few weeks so that we can exploit the work of the present Symposium. Your Departmental Secretaries will be receiving, soon, letters asking for nominees to serve on this Committee. Although there are a large number of offices in each Military Department that will have an interest in this Committee and, hence, should be represented on it, we would like to keep its size reasonably small, e.g., less than fifteen people. We anticipate that the Committee will not meet more frequently than once a month except possibly while it is planning for a symposium. I suspect that once this Committee is in operation it will become a focal point with respect to cost analysis work in the DOD. If this does happen, then the Committee will be filling a need which has existed for some time.

One of the first topics we would like to discuss with this Committee is the question of cost research projects that do not seem, at the present time, to be adequately covered. Some of the items we have in mind are currently being examined and may, in fact, have been discussed or may be included in the Survey at this Symposium. However, I believe there is need for a more intensive effort on these, and in a few cases somewhat different approaches should be attempted.

By way of example, I would like to list now a few of these areas of current interest so that when the Committee convenes, we will all have had some time to think about them and to identify what work has already been accomplished.

First, you have been exposed at this Symposium to three studies on airframe cost. This may seem like adequate coverage, but even in such a well studied topic there are still some unresolved problems. An obvious one is the effect on unit cost of rate of production. An even more interesting and timely one is the need to develop computational procedures to calculate the program cost of alternative quantities and schedules of several different series of a basic aircraft model which have a high degree of commonality among them. We now face this precise problem in both the F-111 and the A-7 programs.

Also, aircraft engines, avionics and support costs require considerable effort. With respect to engines, there are a few studies which provide us with cost estimating relationships. The problem is not so much a question of performing more studies as it is one of obtaining better data.

There has been a notorious dearth of reliable actual cost data for engines. I hope through CIR that this deficiency will be remedied. However, despite the existence of a reporting system, the data may still be deficient due to the accounting systems employed by the engine manufacturers and the methods by which the DOD contracts for these engines. Therefore, I believe the first order of business is an engine data improvement program. Incidentally, with respect to CIR, we must remember that this new program will really not begin to bear fruit for several years. Therefore, we must continue to rely for some time on ad hoc efforts to "back-fill" this data deficiency.

Next, intensive research is needed to develop avionics cost estimating procedures. There have been some attempts to develop such procedures but I believe even those who have worked on them will agree that the results could be improved by further study. Avionics cost research seems to me to be a particularly exciting and challenging opportunity to do useful work. It's an area where the more conventional statistical regression techniques have not really been very successful -- or at least not as successful as it has been in other

areas. There are probably several reasons for this, but the most important of these seems to be the rapid rate of change in electronics technology. In such a rapidly changing state of the art, the identification of the most significant cost determining variables is particularly difficult. This area offers virtually unlimited opportunities for research -- and, more importantly, the DOD urgently needs to be able to handle avionics in a more knowledgeable fashion.

We need intensive work in support costs -- particularly investment spares. As an example, the Air Force and Navy recently submitted cost data to us for an aircraft that both Services are using. In these data we found that the Navy was requesting almost three times as much money as the Air Force for investment spares per aircraft.

Now, there may be a reason for this -- but it is certainly not apparent. The methods for estimating spares requirements must be made more explicit, must be related in a precise way to operating procedures, and finally, must be -- together with replenishment spares -- related to actual consumption data by aircraft.

With respect to missiles, you are already aware that PRC is performing a flyaway missile cost study for OSD. A big gap, however, exists with respect to related electronics and launch equipment for surface based missiles. I would like to recommend it as a fruitful area for some rather intensive and continuing research.

Cost estimating relationships for Navy ships is a potentially fruitful area that needs considerable attention. You heard an interesting paper at this Symposium dealing with Escort ships that represents a very promising beginning. In addition to this work, the Institute for Defense Analyses has recently undertaken a ship construction cost study for OSD, and the Bureau of Ships has a most impressive computer program under development which will yield, in apparently great detail, ship designs and the estimated construction costs for these designs. All of these activities sound impressive. It seems, however, that somewhat closer working relationships should be encouraged so that we might more efficiently exploit all of these activities. We would like to pursue this matter further with the Navy at one of our early Cost Research Committee meetings.

Time does not permit this afternoon to discuss in detail the many other topics of interest that require research. For example, I found no entries at all in the Survey for Army ground vehicles. The problem of indirect and base operating support costs for all types of weapon systems is virtually untouched. Mr. Hoch has already referred to the unsatisfactory situation with respect to operating cost estimating procedures in all three Military Departments. All of the famous, or infamous, horror stories of early under-estimates of weapon system costs, involve only R&D and investment costs. Rarely

do we compare, where our accounting system permits such comparisons, original forecasts of operating cost for a new weapon system with what it actually costs to operate in service. Yet, in many cases, these operating costs may be as large or larger than the R&D and investment costs. It is absolutely essential that we begin a concentrated assault on the major elements of operating cost as soon as we can muster the resources. This problem will also be on the agenda for an early meeting of the Cost Research Committee.

My final point is a general one, but it is probably the most important of all. Three years ago, when we in OSD began to campaign for larger and more highly skilled cost analysis offices, it was our intention that these offices would satisfy a variety of needs within each Military Department. We explicitly stated to the Assistant Secretaries for Financial Management and Installations and Logistics of the three Military Departments that these cost analysis offices should assist in weapon systems and requirement studies, they should supply data and analyses for programming and budgeting, they should support project managers, and, finally, they should be requested to assist in contract negotiations. It was our view then, and it is our view now, that the DOD has a far greater potential to predict the cost of a new weapons system than any single contractor, whether for requirement studies, budgeting, programming, project management or contract negotiations. This point should be obvious since our experience is based on all the weapons produced for DOD while a single company has only its own past programs as an experience base. We have only to exploit this potential. If your cost analysis office is not fully utilized by the systems analysts, program and budget analysts, project managers and contract negotiations in your Service, then the DOD is not making efficient use of the resources it has devoted to performing cost analysis. It is not only necessary for your "customers" to know they need your help and seek it out, it is equally important for you to let these people know you exist and, by deed, to demonstrate your value to them. Until your offices are fully exploited by these other DOD activities, we will not have achieved the goal we set for ourselves three years ago. Whether or not we succeed in this depends to a large extent on your ability to perform high quality, operationally useful work and on your aggressiveness and persistence in communicating this ability to potential users in your Services.

I would now like to close this first DOD Cost Research Symposium. I would like to thank Saul Hoch, Harry Hatry and Colonel Bramson of my office and the Army, Navy and Air Force representatives who collaborated to make this Symposium the success I feel it has been. I hope you all share this view.

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